Drought Response Outreach Program for Schools (DROPS)

Technical Assistance Support

drops
Drought Response Outreach Program for Schools

Friday, November 14, 2014

Presentation Outline

- Low Impact Development (LID)
- Project feasibility
- Sizing your LID project
- Estimating project costs
- Estimating water quality benefits

Module 1:

LID and Project Feasibility

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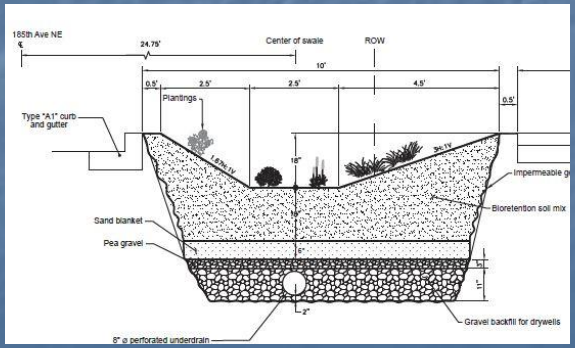
Low Impact Development

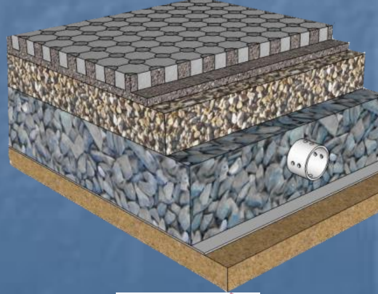
- LID designs mimic how rainwater would naturally interact with the landscape (slow, spread, sink).

Low Impact Development

- LID designs are intended to reduce stormwater runoff volumes and pollutants.
- The surface of a LID feature may not look like anything special, but underneath, they are designed to work hard!

Morton Arboretum, Illinois





Project Feasibility

- Understand how stormwater is currently managed. Often the existing system provides an opportunity to intervene with a LID design.

- Consider whether the project is compatible with current uses and features.

Project Feasibility

- Getting stormwater to your project
  - Are there locations where stormwater runoff can be intercepted to slow, infiltrate and/or treat?

Parking Lots

Figure 33. Pervious Paver Parking Stalls, Redlands, CA.
Source: Jeff Endicott

Project Feasibility

- Getting stormwater to your project
  - Are there locations where stormwater runoff can be intercepted to slow, infiltrate and/or treat?

Buildings

Project Feasibilty

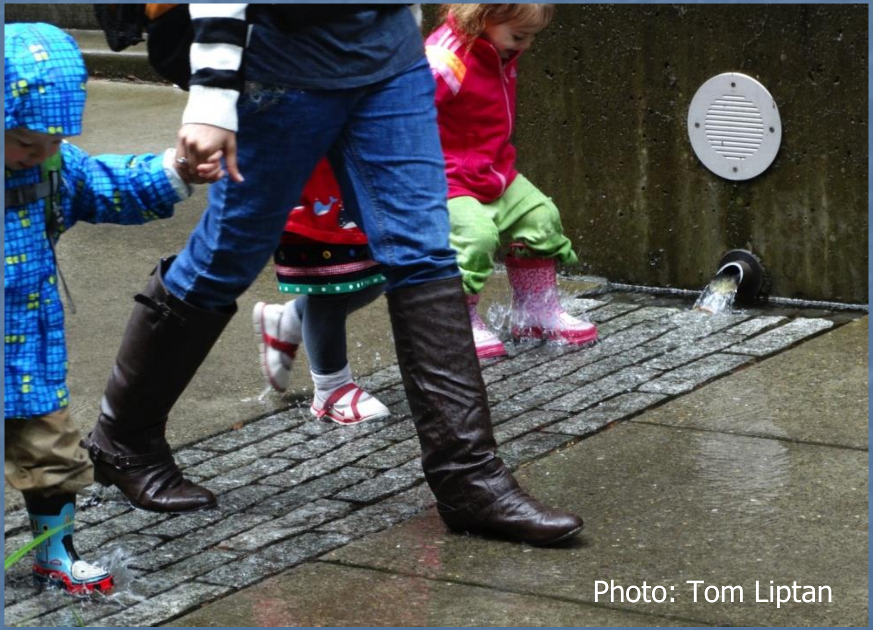
- Can excess stormwater exit via a curb cut, overflow or underdrain?

Curb Cut

Sheet Flow

Project Feasibilty

- Can excess stormwater exit via a curb cut, overflow or underdrain?



Flush Channel

Open Channel

Project Feasibilty

- Can excess stormwater exit via a curb cut, overflow or underdrain?

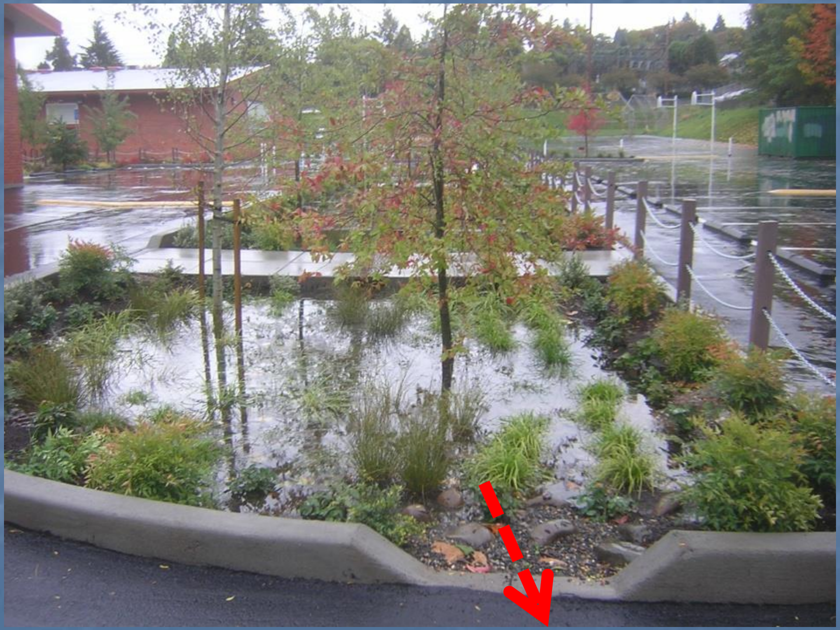
Trench Drains

Photo: Stacy Levy

Fun!!

Project Feasibilty

- Can excess stormwater exit via a curb cut, overflow or underdrain?



Curb Cut

Overland Sheet Flow

Project Feasibilty

- Can excess stormwater exit via a curb cut, overflow or underdrain?

Existing Exterior Overflow Inlet

Existing Interior Overflow Inlet

Project Feasibilty

- Can excess stormwater exit via a curb cut, overflow or underdrain?

Overflow Drain Inlet

Underdrain System

Project Feasibility

- For disconnection to be safe and effective, each downspout must discharge into a suitable receiving area. Runoff must not flow toward building foundations or cause flooding.

Project Feasibility

- Consider existing uses and features
  - Can the existing function be altered?
  - Proximity to buildings, slopes, utilities

Project Feasibility

- Can the existing function be altered?

Project Feasibility

- Pedestrian considerations

Project Feasibility

- Proximity to buildings

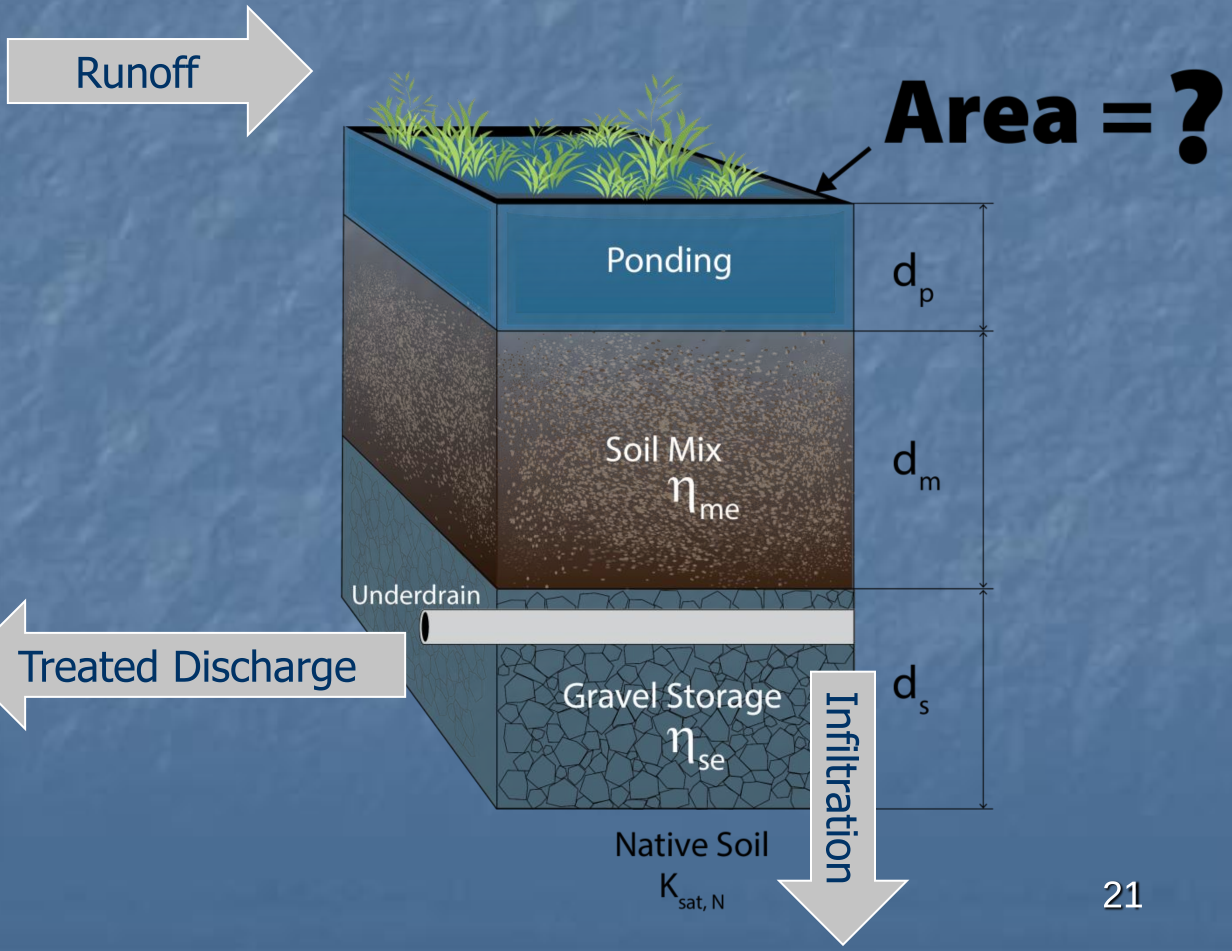
Seaquam Secondary School Rain Garden
http://www.vcn.bc.ca/cougarcr/raingardens.html

Project Feasibility

- Existing utilities
- Seasonal high groundwater depth
- Native soils
- Steep Slopes
- Sizing constraints

Module 2:

Sizing Your LID Project



Sizing Your LID Project

- Cumulatively, small storms represent the greatest annual volume and pollutant load.
- LID projects are typically sized to capture/treat the small storms.
- The small storm size is often called the "water quality design storm" and usually equates to the 85th percentile, 24-hr storm event.

LID Sizing Tool

- The Office of Water Programs at CSU Sacramento have created an online tool to determine the required sizing of common LID project types.
- The tool uses three inputs to determine LID dimensions:

  -design storm depth (precipitation)

  -soil conductivity (infiltration rate)

  -contributing impervious area

Sizing Steps

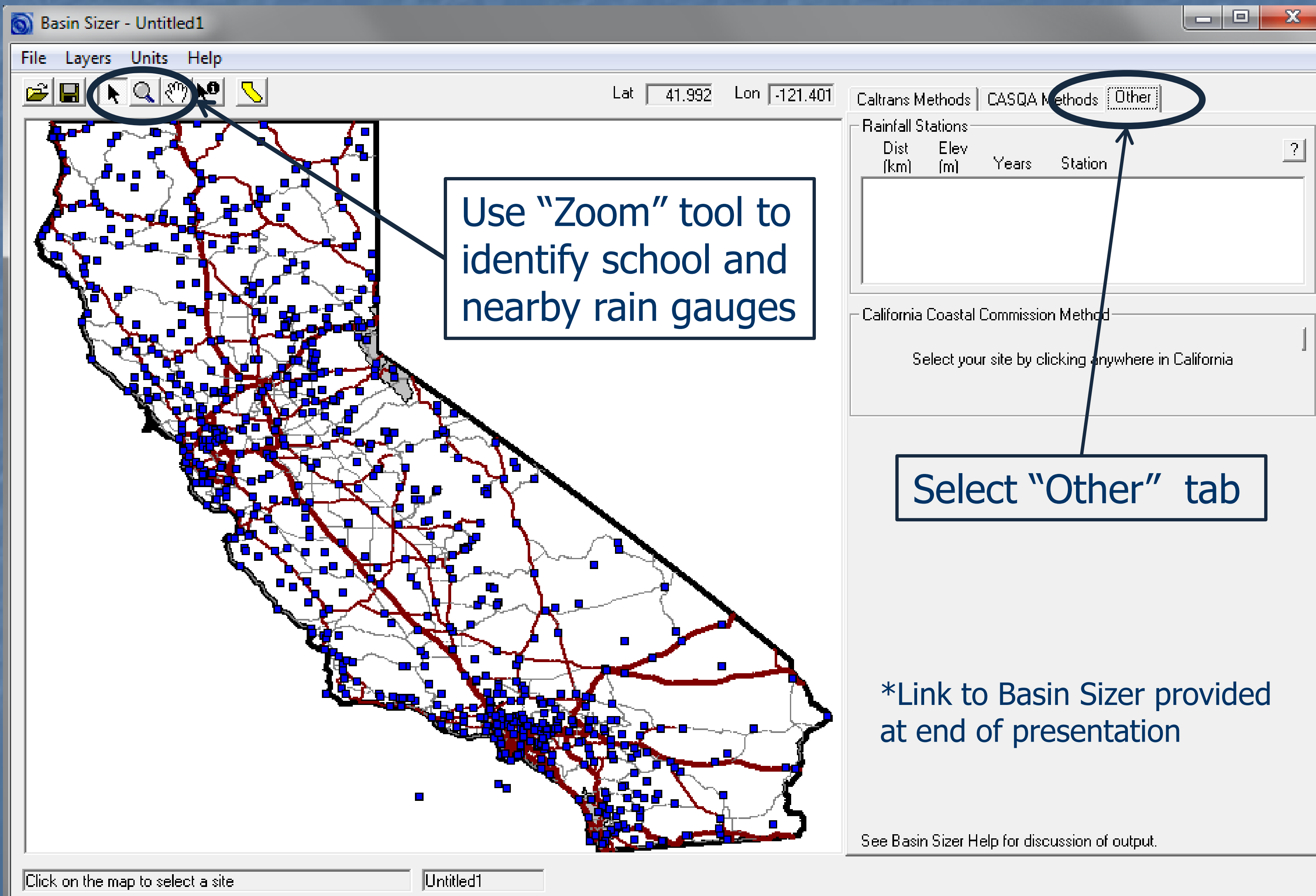
- 1. Determine input for tool
- 2. Enter input
- 3. Review the areas provided in the table
- 4. Choose an LID BMP
- 5. Re-evaluate feasibility

(detailed steps are available in pdf)

Step 1. Determine Tool Input

- Design Storm Depth: 85th percentile, 24-hr
  - Use Basin Sizer Tool
- Soil Conductivity
  - Use field data if available, or
  - Obtain from local records, or
  - Use NRCS data (available in LID Tool)
- Contributing Impervious Area
  - Use LID Sizing Tool's measuring option

Determine Design Storm Depth

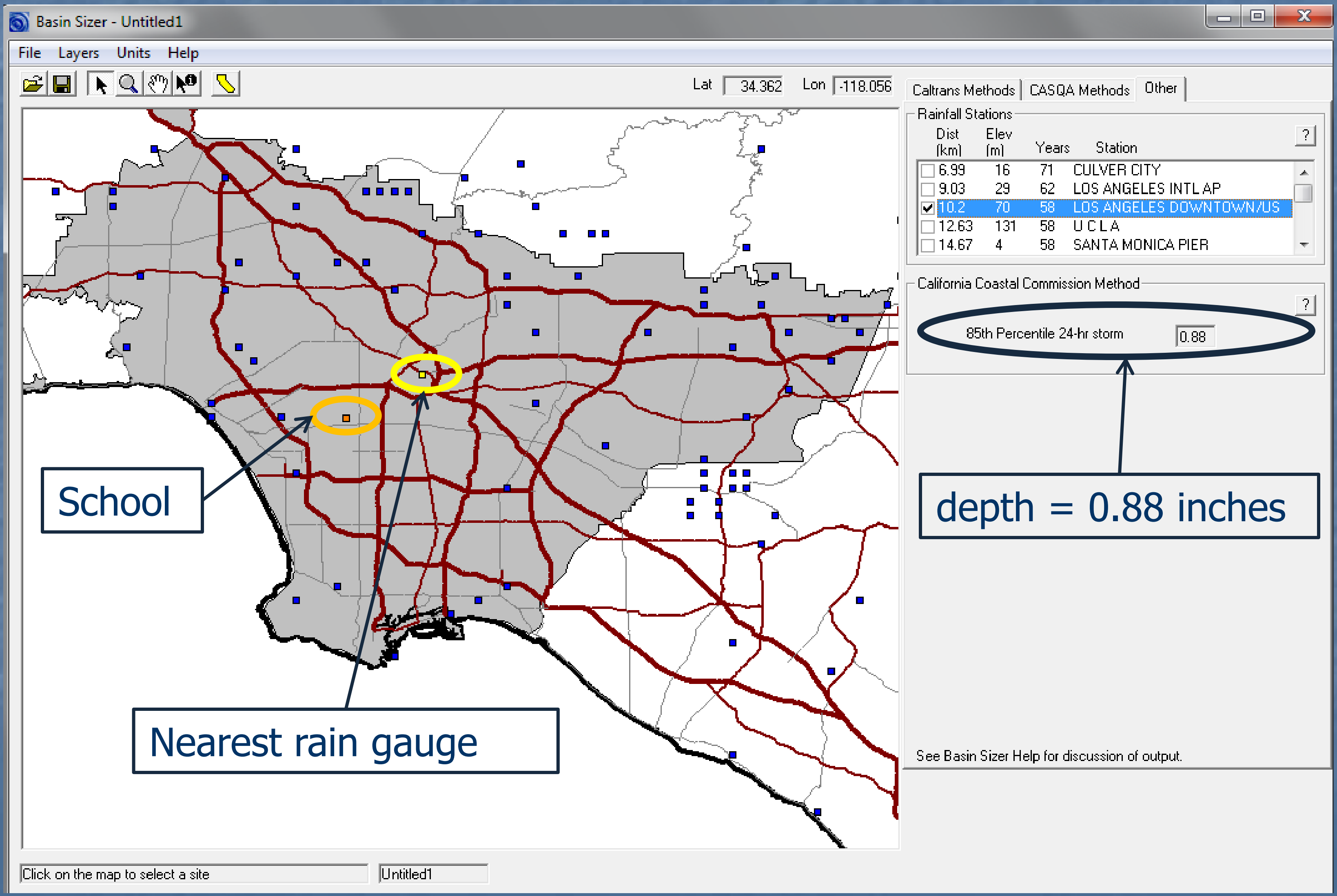


Use “Zoom” tool to identify school and nearby rain gauges

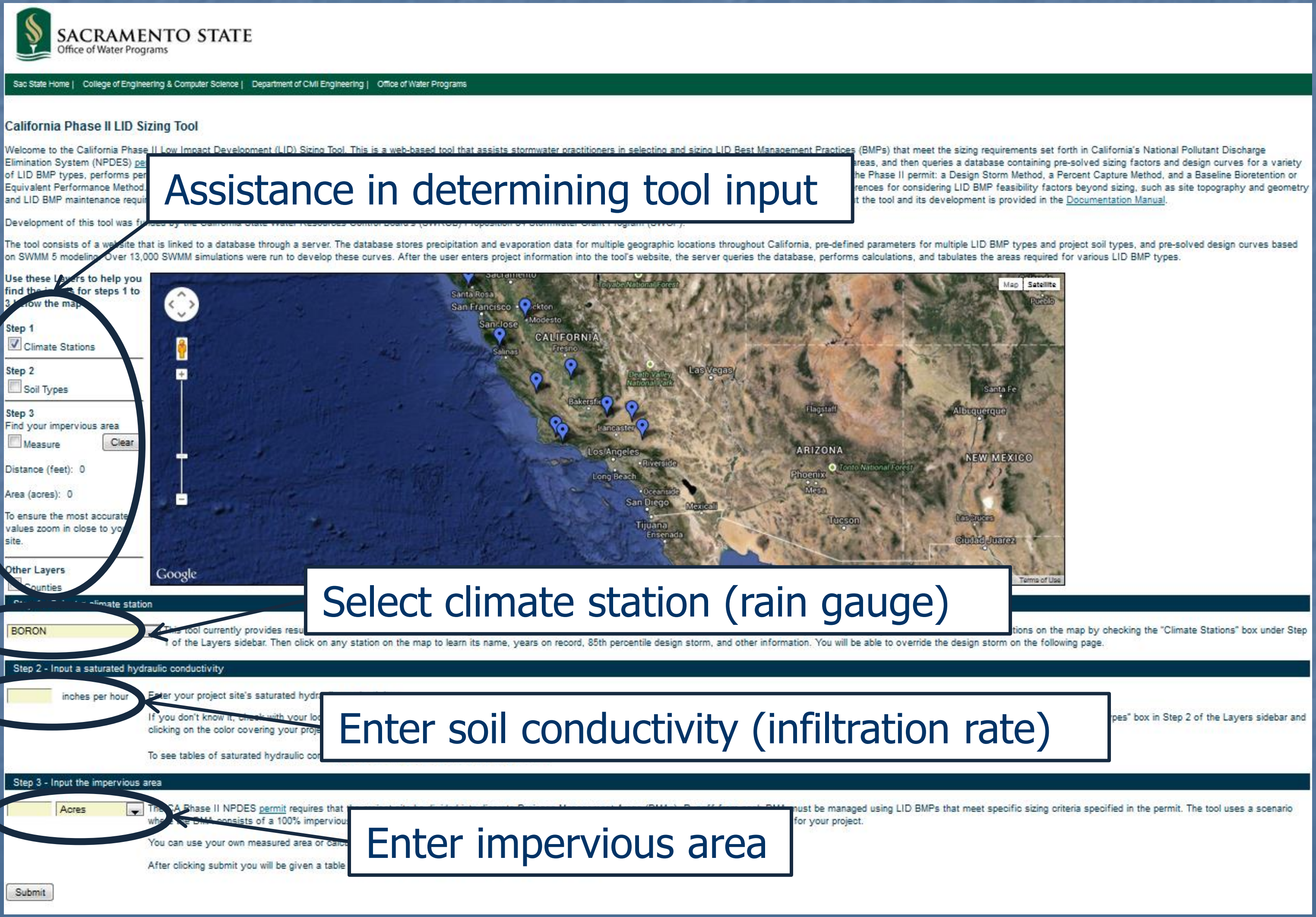
Select “Other” tab

*Link to Basin Sizer provided at end of presentation

Determine Design Storm Depth



Step 2. Enter Input



Step 3. Review Area Table

Storm Water Treatment Measures				
LID BMP Types	Permit Compliant LID BMP Areas (square feet)			
	Design Storm 0.88 inches[1, 8]	Percent Capture[2]	Baseline Bioretention or Equivalent	Central Coast Simple Method
Bioretention Cell - 18" Soil - 12" Gravel Storage	325	[illegible]	[illegible]	[illegible]
Bioretention Cell - 18" Soil - 24" Gravel Storage	253	425	236	637
Bioretention Cell - 18" Soil - 36" Gravel Storage	207	412	230	409
Bioretention Cell - 24" Soil - 12" Gravel Storage	290	421	234	1442
Bioretention Cell - 24" Soil - 24" Gravel Storage	231	[illegible]	[illegible]	[illegible]
Bioretention Cell - 24" Soil - 36" Gravel Storage	192	[illegible]	[illegible]	[illegible]
Bioretention Cell - Soil Depth Varies[5] - No Gravel Storage	2370	[illegible]	[illegible]	[illegible]
Infiltration Basin - Vegetated	4275	N/A	N/A	4275
Infiltration Gallery	935	N/A	2087	935
Infiltration Trench	3050	N/A	N/A	3050
Overland Flow no amendment	N/A	N/A	N/A	N/A
Porous Pavement	3150	N/A	3267	3150
Strip, Amended 6"	5205	N/A	3758	5205
Strip, Amended 12"	1760	N/A	2259	1760
Strip, Amended 18"	1059	[illegible]	[illegible]	[illegible]
Swale, Amended 6"[6]	5205	[illegible]	[illegible]	[illegible]
Swale, Amended 12"[6]	1760	N/A	N/A	1760
Swale, Amended 18"[6]	1059	N/A	3535	1059
Capture and Use Storage[7]	409 cf	1910 cf	2170 cf	409 cf

[1] Complies with Phase II permit design storm sizing criteria (Section E.12.e.ii.c.1.a)

Select a design storm depth in inches 0.88 (The [illegible]th percentile design storm for this location is: 0.96 in) Submit

Use areas from Design Storm column

LID BMPs (click on an area to see details)

Override default design storm

Step 4. Select LID BMP

California Phase II LID Sizing Tool - BMP Details

Summary

Project nam[illegible]	
Cli[illegible]e station	SANTA BARBARA MUNI AP
[illegible]aturated hydraulic conductivity	0.03 in/hr
Impervious area	6100 square feet
LID area	253 square feet
Total area	6353 square feet
LID BMP	Bioretention Cell - 18" Soil - 24" Gravel Storage
Met[illegible]ology	Design Storm User selected design storm is 0.88 inches 85th % design storm is 0.96 inches
Design storm volumet[illegible]ff coefficient	0.892

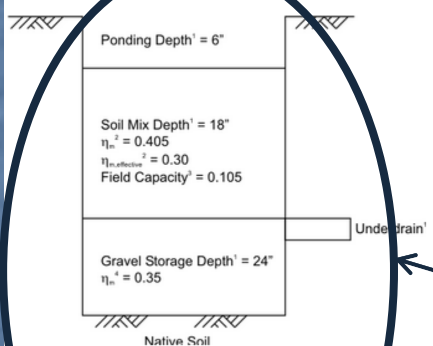
Summary of project input and LID BMP

Description

[illegible]oretention cells are depressed landscapes into which runoff is directed and allowed to pond, filter, and infiltrate. Some bioretention cells modeled by the CA Phase II LID Sizing Tool consist of the design parameters specified in Section E.12.e.ii.f.3 of the Phase II permit, including a [illegible]ding depth underlain by 18" of bioretention soil mix and 12", 24", or 36" of gravel storage. (The Phase II permit requires a minimum storage depth of 12".) The ponding zone allows for temporary storage of runoff and promotes percolation into the bioretention mix. The runoff is also stored in the m[illegible]s [illegible]structure, as well as being filtered and biotreated. It eventually drains into the gravel layer below which provides a third storage component. A perforated underdrain is located at the top of the gravel storage component to prevent overflow of the system. This system is unlined [illegible]ow infiltration [illegible] native soils. The Central Coast Regional Water Quality Control Board (Region 3) has adopted a variation on the permit-prescribed bioretention cell, where the soil mix depth is to be 24", and so the tool includes bioretention cells having [illegible] ponding, 24" of soil mix, and 12", 24", or 36" of gravel storage [illegible]

Narrative description of LID BMP

LID BMP - Biorete[illegible]on Cell - 18" Soil [illegible]4" Gravel Storage



LID BMP schematic and assumptions

[illegible]pths

L[illegible]D Layer	Depth (inches)
Po[illegible]ding	6
Soil [illegible]ix	18
Grave[illegible] storage	24

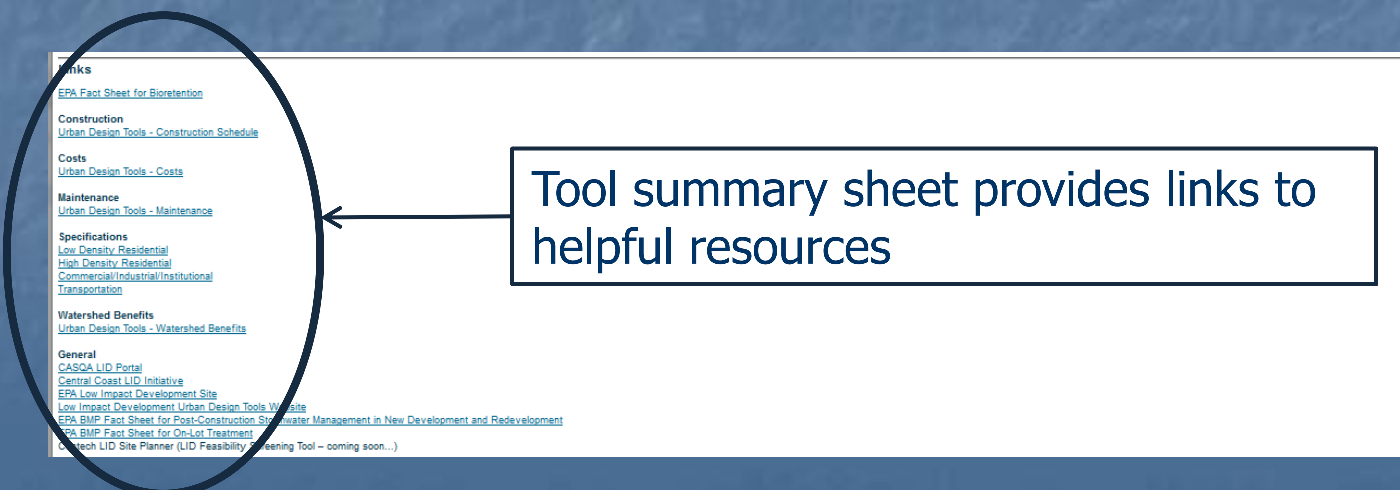
Notes

1. SWRC[illegible]013, LID standard for bioretention, p. 54[illegible]CRWQCB 2013, post-construction requirement for water quality treatment, p. 4.
2. Effective [illegible]osity (total porosity – field capacit[illegible]. VA DCR 2011, 25%; District DOE 2013, 30%; WI DNR 2010, 27%; Prince George 2013, 30%; NC Co-op 2009, 30%; LID Center 2010, 30%. Assume Total porosity = 30% + field capacity.
3. Caltrans 2010, [illegible]5% for infiltration trenches; [illegible]ty of Santa Barbara 2008, 30-40% commonly 32%; WI DNR 2010, 33%; NC Co-op 2009, effective porosity 25%. Assume field capacity = 0.
4. USEPA 2010. Fiel[illegible]acity for loam[illegible]nd = 0.105.

Note: Excavation depths should consider root uplift and expansion within the soil mix layer

Step 5. Re-evaluate Feasibility

- Do I have enough space?
- Will utilities interfere?
- Is the topography appropriate?
- Do I have enough groundwater clearance?
- Can I commit to the maintenance?



Project Examples
59th St. Elementary, Los Angeles

- Tool Input
  - Design storm = 0.88 inches
  - Soil conductivity = 0.03 in/hr
  - Impervious area = see values below
- Three scenarios
  - Direct roof runoff to bioretention (6,100 sf)
  - Direct roof runoff to cistern (6,100 sf)
  - Replace conventional pavement with porous pavement (6,000 sf)

http://owp-web1.saclink.csus.edu/LIDTool/Start.aspx

Module 3:

Estimating Costs and Water Quality Benefits

Bioretention swale at the LA Zoo Photo: Ciara Gonzales

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DROPS Project Budget

- Project Administration
- Planning/Design/Engineering/Environmental
- Construction/Implementation
- Monitoring/Performance
- Education/Outreach

Estimating Design/Construction Costs

- Costs can vary widely
- Information provided in this presentation is drawn from reported values; and, experience from the technical assistance team
- Try to refine costs estimates to the best of your ability
- Take into consideration in-kind labor and expertise

Estimating Design/Construction Costs

- Often, 10%-30% of construction cost
- Small projects may be similar in effort as medium sized projects
- Degree of complexity, permitting requirements, etc. may increase cost

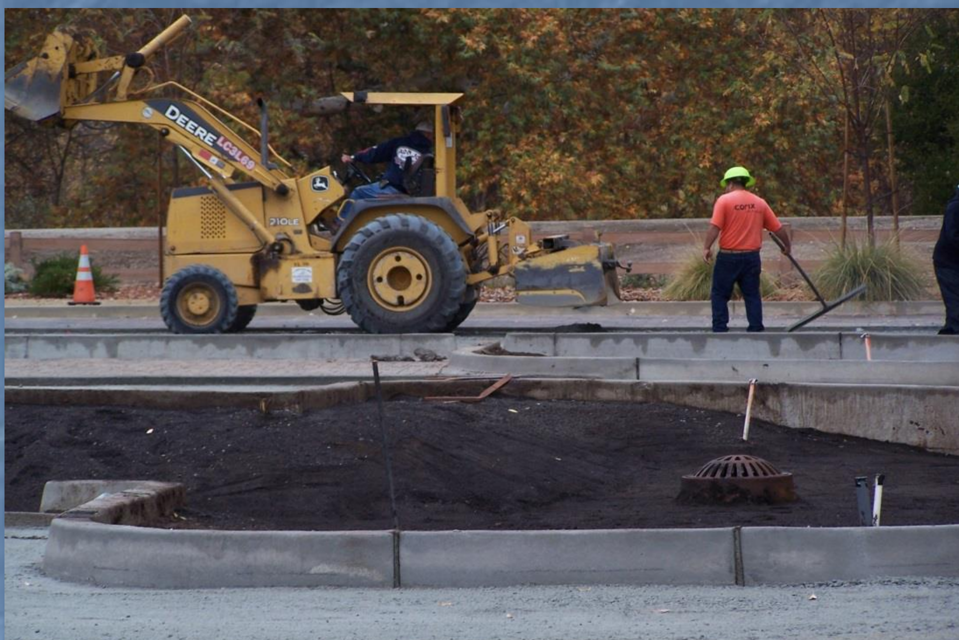
Estimating Design/Construction Costs

- Construction/Implementation
  - Bioretention
  - Pervious Pavements
  - Cisterns

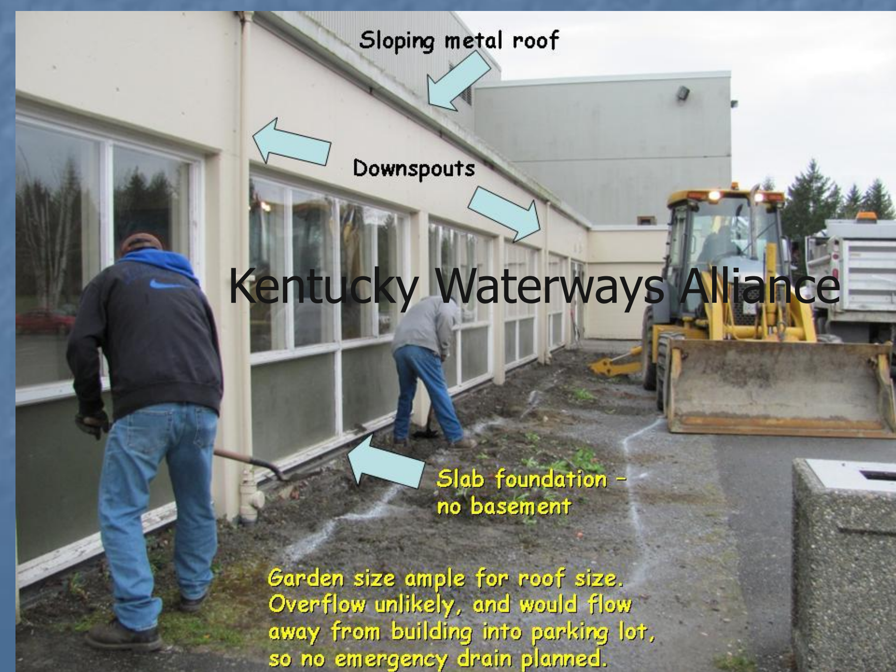
Estimating Costs: Bioretention

- Construction/Implementation
  - Ranges from $5-$75 / square foot
  - Cost depends on level of complexity
    - Amount of material removal (e.g. concrete)
    - Depth of excavation
    - Materials
    - Grading, routing, pipes, structural stability for surrounding infrastructure, etc.
    - Design elements (e.g., sidewalls, curb, aesthetic)

Estimating Project Costs: Bioretention



vs.

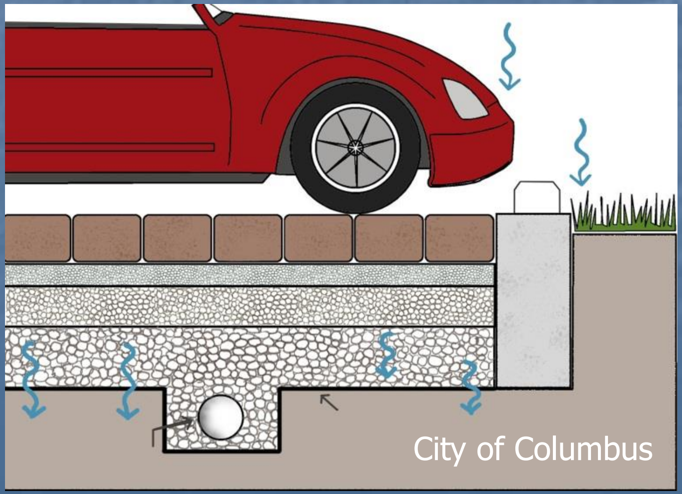


Estimating Construction Cost: Bioretention

LID Project Type	Low Complexity	Moderate Complexity	High Complexity
Bioretention	No impervious removal required (e.g., asphalt, concrete). Little to no hard infrastructure such as curbs, overflow devices, retaining walls, weirs, etc. Example: alteration of an existing landscape area that can be easily retrofit to receive stormwater from a roof downspout disconnection.	May require some removal of impervious material, alteration of an existing overflow, simple curb cuts, etc. Example: addition of a curb-bulb extension bioretention design where existing stormwater routed via curb/gutter can be intercepted at upgradient and exit via curb cut at downgradient.	Requires hard infrastructure such as concrete walls/supports, addition and connection of underground conveyance infrastructure such as underdrains and pipes. Example: A planter box style bioretention that requires concrete sidewalls and underground connection to the existing stormwater drainage system.
Construction Cost Range	$5-$20 / square foot	$20-$50 / square foot	$50-$75 / square foot

Estimating Project Costs: Pervious Pavements

- Cost depends on:
  - Type selected
  - Site preparation
  - Incorporation of artistic design



Estimating Cost: Permeable Pavements

- Typical Installed Costs (placement and materials)
  - Asphalt: 50c to $1 per square foot.
  - Grass/Gravel Pavers: $1.50 to $5.75 square foot.
  - Porous Concrete: $2.00 to $6.50 square foot.
  - Interlocking Concrete Paver Blocks: $5.00 to $10.00 square foot.




Estimating Project Costs: Permeable Pavements

- Site preparation, required infrastructure, etc. generally not included in installed cost estimate.

Atascadero Zoo

Spectrum Community School

Estimating Project Costs: Permeable Pavers

- Getting artistic with pavers adds cost


Chesapeake Stormwater Network

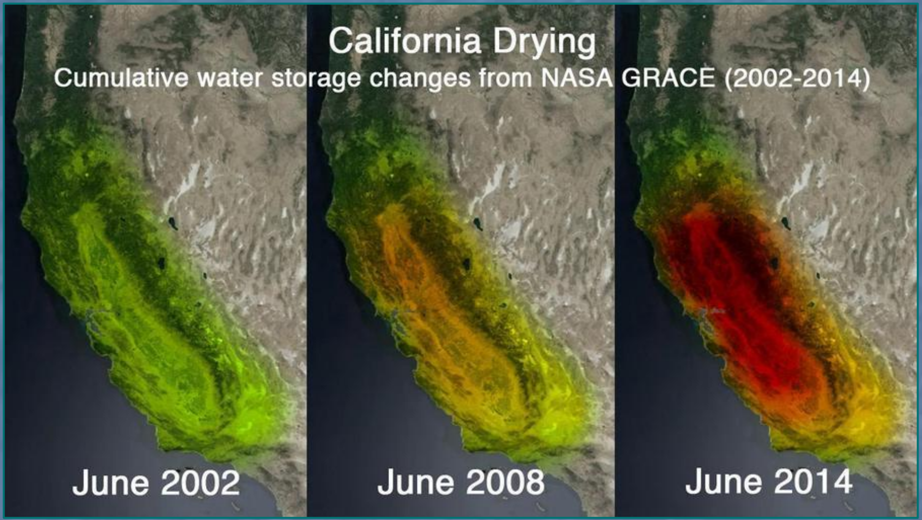

Annapolis & Chesapeake Bay Visitor's Center

Estimating Costs: Cisterns

- There may be several components required for the system.
- There are several cistern styles that range in size and material.
- Best to check with a local supplier to get a system estimate.

Estimating Water Quality Benefits

Photo: fresnoalliance.com



Ballona Wetlands, Los Angeles

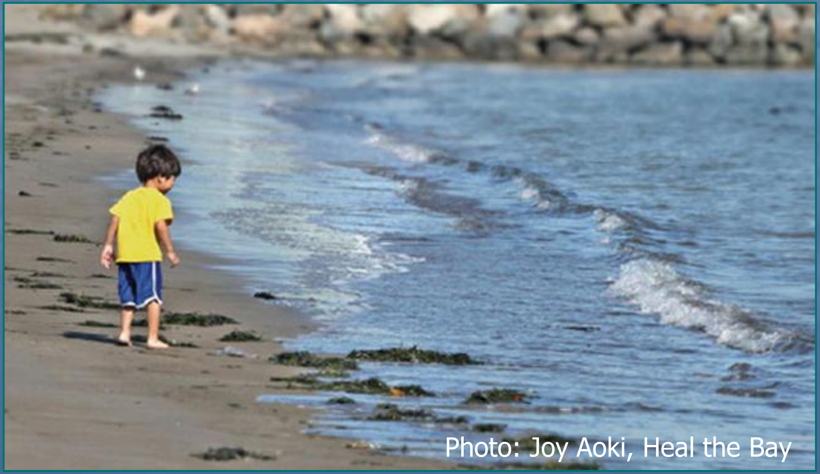


Photo: Joy Aoki, Heal the Bay

Estimating Water Quality Benefits

- For LID Projects
  - Estimated volume of stormwater that will be captured (gallons per year), and;
  - If the project will capture stormwater pollutants, what is the approximate amount captured per year.

Estimating Water Quality Benefits

- Estimated volume of stormwater that will be captured (gallons per year)
  - Capturing storms up to and including the 85^{th} percentile, 24-hr storm event is approximately 80% of the average annual volume.
  - We will use this general relationship to estimate average annual volume managed.

Estimating Average Annual Volume Captured

Calculation of Average Annual Volume Managed							
	A	B	C	D	E	F	**G**
	Contributing Impervious Area (square feet)	LID facility area receiving direct rainfall (square feet)	Average Annual Precipitation (in)	Average Annual Precipitation (feet)	Annual Volume (cubic feet) [(A+B)*D]	Annual Volume (gallons)	**Average Annual Volume Managed (gallons) [0.8 * F]**
LID Project	3049	131	20	1.67	5,300	39,643	**31,714**

- The contributing impervious area was calculated with the LID Sizing Tool. Example: a roof area contributing runoff a rain garden.
- The LID facility size was determined with the LID Sizing Tool.
- Average annual precipitation can be obtained on-line (e.g., city website).

conversion inch to feet	0.08
conversion cubic feet to gallons	7.48

Estimating Water Quality Benefits

- If the project will capture stormwater pollutants, what is the approximate amount captured per year

Estimating Water Quality Benefits

- There are different pollutant types and different concentrations depending on the type of surface being treated (e.g., rooftop, parking lot), so you need to select appropriate values.

Estimating Water Quality Benefits

- Typical Urban Runoff Pollutant Concentrations for Different Surface Type

Stormwater Surface Pollutant Loads

Constituent	TSS[1] (mg/L)	Total Copper[1] (ug/L)	Total Zinc[1] (ug/L)	Total Phosphorus[1] (ug/L)	Pb[2] (ug/L)	F Coli.[2] (1,000col/ml)	Total Nitrogen[2] (mg/L)
Commercial Roof	13.5	10.5	268.5	140	17	1.1	2.1
Parking Lot	51	44	118	145	28	1.8	1.9
Walkway[1]	25	13	59	110	not reported	not reported	0
Street[3]	101	33	135	383	144	*	2.6

[1]Average from New York Stormwater Management Design Manual and NRDC Report.

[2] Value from NRDC Report

[3] Means from Nationwide Urban Runoff Program values for Residential Land use

*fecal coliform concentrations vary widely, ranging between 400-50,000 mpn/100 ml. Lastly, Medium density residential land use was stated as having and EMC concentration of 1.25 mg/l Total Petroleum Hydrocarbons (TPH).

Estimating Water Quality Benefits

Calculation of Average Annual Pollutant Reduction					
	A	B	C	D	E
	Average Annual Volume Managed (gallons)	Pollutant Concentration for Surface Type. Example: Average Copper concentration from Parking Lots (ug/L)	Average Annual Volume Managed (L) (1 gallon equals 3.79 L)	Average Annual Copper Managed (ug) [B*C]	Average Annual Copper Managed (grams)
LID Project	31,714	44	120,196	5,288,627	5

- We again use the relationship that by managing the 85th percentile, 24-hr storm event, we are managing approximately 80% of the average annual volume and associated pollutants.

- Need to make sure you are calculating the correct polluted runoff volume. May not be the same volume as calculated for average annual runoff volume managed.

Resources

- Caltrans Basin Sizer: http://svctenvims.dot.ca.gov/wqpt/basinsizer.aspx
- LID Sizing Tool: http://owp-web1.saclink.csus.edu/LIDTool/Start.aspx
- http://www.flowstobay.org/files/greenstreets/GreenStreets_booklayout_Guidebook.pdf
- New York State Stormwater Design Manual. "The Simple Method to Calculate Urban Stormwater Loads". Appendix A.
- Natural Resources Defense Council (NRDC). "Investigation of the Feasibility and Benefits of Low Impact Site Design Practices Applied to Meet Carious Potential Stormwater Runoff Regulatory Standards." December, 2011.
- Nationwide Urban Runoff Program (US EPA 1983)
- Technical Assistance Team. Contact: dainglis@ucdavis.edu